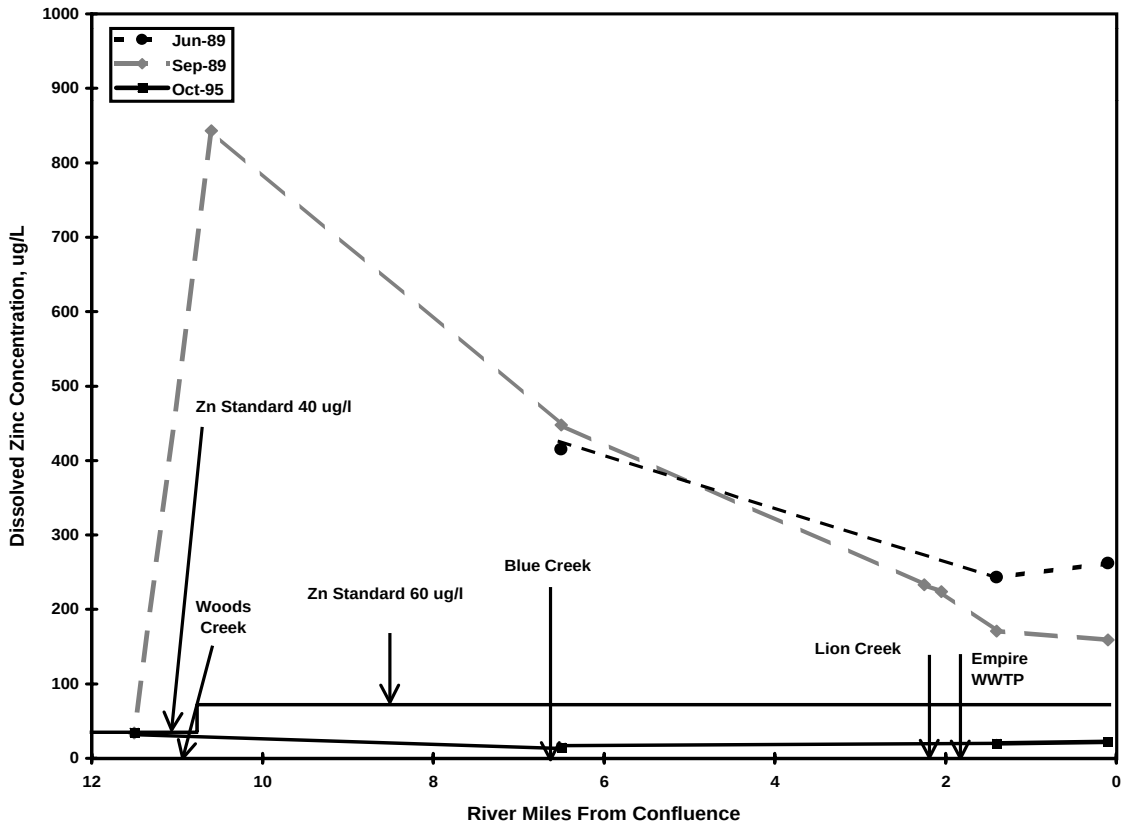
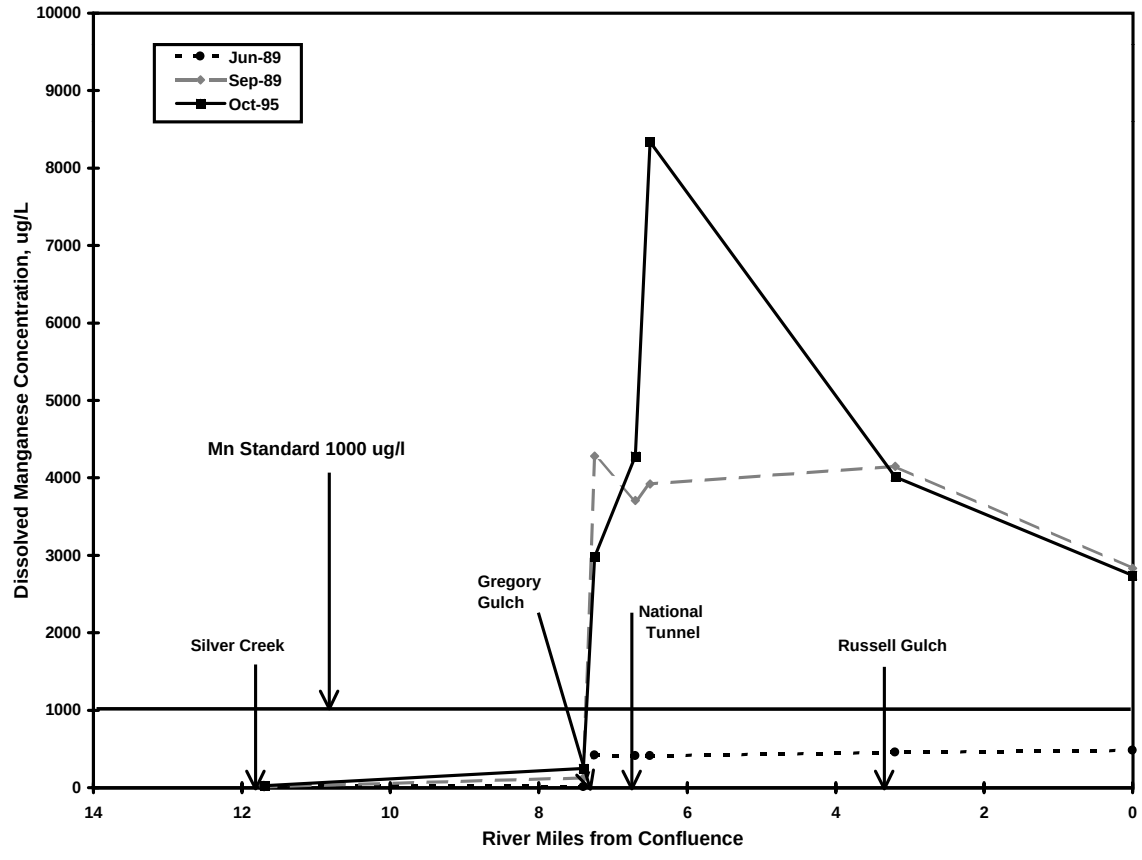


DISSOLVED ZINC IN THE WEST FORK OF CLEAR CREEK

Zinc levels in the West Fork of Clear Creek have dropped significantly since Cyprus-Amax began treating water coming from the Henderson and historic Urad mines. The West Fork of Clear Creek has the highest quality habitat in the Clear Creek watershed. Now with the improvements in water quality, the West Fork fishery is expected to rebound. Data are from EPA and CDPHE Superfund studies.



DISSOLVED MANGANESE IN THE NORTH FORK OF CLEAR CREEK

Manganese levels in the North Fork of Clear Creek are very high, frequently exceeding the state stream standard, especially below Black Hawk. The Gregory Incline, Gregory Gulch, and the National Tunnel in Black Hawk are a few of several possible sources of the manganese. Data are from EPA and CDPHE Superfund studies.

MANGANESE

Manganese is a metal which in nature is usually associated with iron compounds which are abundant in the Clear Creek basin geology. Manganese is an important nutrient in trace amounts for both plants and animals. There is no primary drinking water standard for manganese. Even so, humans, especially infants, should not drink water containing manganese levels, more than 800 micrograms per liter (ug/l), for an extended length of time. This is because manganese at high levels can cause damage to the central nervous system. A more common concern with manganese is that even low levels of the metal can discolor water, stain laundry, and cause the water to have a bad taste resulting in a customer perception that the water is unsafe to drink. Levels of manganese in water below 50 ug/l, the secondary drinking water standard, should not have these problems.

ZINC

Zinc, along with other metals such as cadmium and copper, is found in ample quantities in the minerals typical of the Clear Creek area. Zinc is also present in Clear Creek itself. Zinc has come to be used as the "indicator" of metals in Clear Creek, because its presence in the basin is wide spread; it tends to stay in the water rather than precipitating to the sediments; it is often found along with the other metals; and it is easy to analyze. Zinc is a necessary trace element for humans, but is toxic to fish and other aquatic life. The State of Colorado has set water quality standards for zinc in Clear Creek which are intended to protect aquatic life, but at the same time recognize that certain parts of Clear Creek have been degraded by zinc and other metals. The zinc standard for Clear Creek ranges from below 50 ug/l in certain headwater stream reaches to 740 ug/l in others.

FOR MORE INFORMATION:

Clear Creek Phase II Remedial Investigation Report, prepared by Camp, Dresser, and McKee for the Colorado Department of Public Health and the Environment, September 21, 1990.

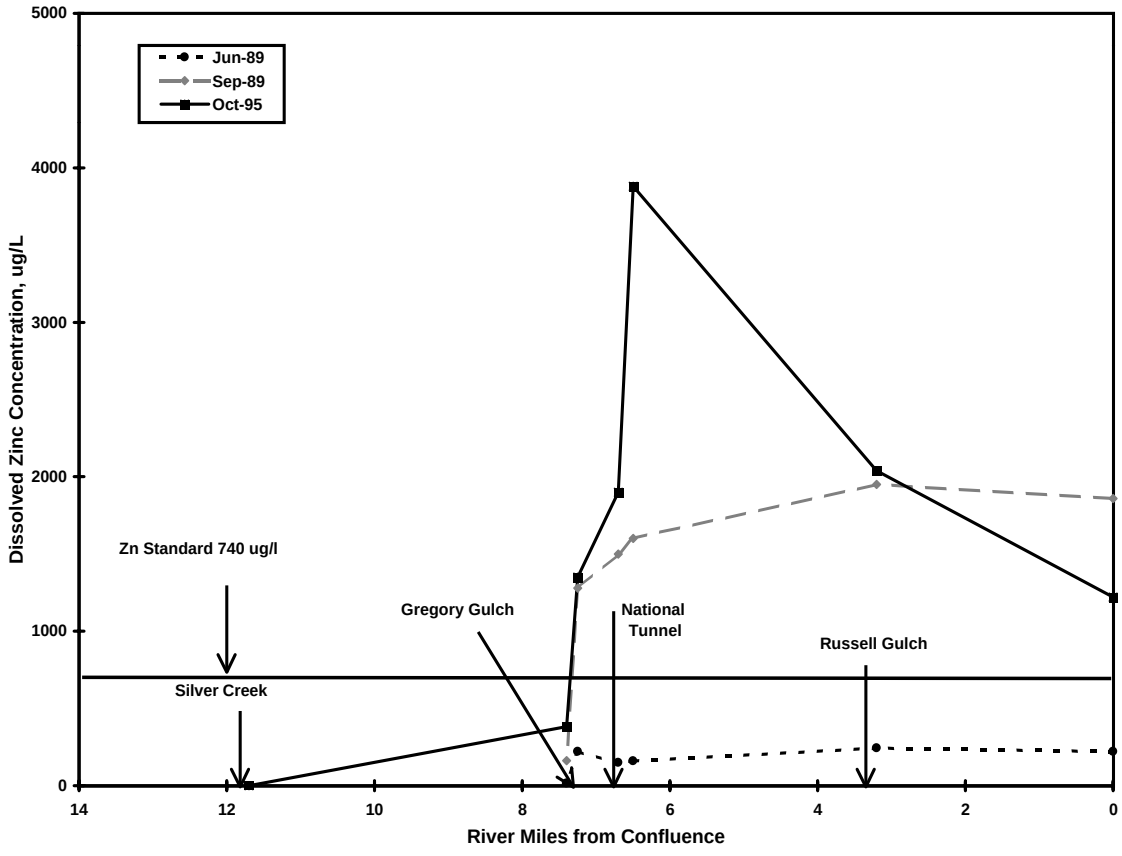
Contaminant Transport Modeling in the Mainstem of the Clear Creek Basin, prepared by Walsh and Associates for the Environmental Protection Agency, September 30, 1992.

Chemical and Physical Assessment of North Clear Creek During July 1994, prepared by Water Science for the Environmental Protection Agency, May 1995.

Chemical, Physical, & Biological Assessment of Clear Creek and Selected Tributaries in the Clear Creek Basin During Fall 1995, prepared by Water Science for the Environmental Protection Agency, September 1996.

DISSOLVED ZINC IN THE NORTH FORK OF CLEAR CREEK

Zinc levels in the North Fork of Clear Creek show a similar pattern to manganese. The state stream standard is frequently exceeded, especially below Black Hawk. The Gregory Incline, Gregory Gulch, and the National Tunnel in Black Hawk are a few of several possible sources of the zinc. Data are from EPA and CDPHE Superfund studies.



IV. LIMITING FACTORS (CONT)

Toxicity

Fish and other aquatic life, such as the insects on which the fish feed, are affected by long-term exposure to low concentrations of metals. This is called "chronic toxicity." Chronic toxicity can cause death or non-lethal effects such as stunted growth, reduced reproduction, and physical deformities. Metals such as zinc, cadmium, and copper exist in the water and sediment at chronic toxicity levels in many locations in Clear Creek.

Whether or not a metal or combination of metals is toxic depends upon the organism's tolerance to the metal. For example, brook trout are generally more tolerant of zinc than brown trout, which in turn are more tolerant than rainbow trout. Water quality characteristics that affect toxicity include pH, hardness, and the chemical form in which the metal is found. Hard water—water that carries a lot of minerals such as calcium and magnesium—tends to reduce the toxicity of metals to fish.

CDPHE and EPA have conducted several toxicity studies in Clear Creek. Map 6 summarizes some of that information.

CHRONIC TOXICITY VALUES FOR DIFFERENT TROUT SPECIES

Chronic toxicity values depend upon both the metal and the aquatic species.

Metal	Rainbow	Brown	Brook
Cadmium	0.7-1.5	2.0*	1.7-3.4
Copper	11.4-31.7	22.0-43.2	9.5-17.4
Zinc	47.0	225	532-1370

**acclimated trout*
(Values are in ug/L)
Data from CDOW, 1991.

TOXICITY TESTING

Toxicity tests determine if water or sediment are toxic to fish and aquatic life. Lab-grown test species, rather than living inhabitants of Clear Creek, are most often used to determine toxicity levels. The water flea, fathead minnows, algae, and the midge are commonly used test species. The test species are exposed to water collected from Clear Creek. After a period of time, usually 24 or 48 hours, the number of species still living in the water are counted, giving the scientist percent mortality. Percent mortality of 40% means that 4 out of every 10 animals died. Another measure of toxicity is the lethal concentration 50, or LC50. This is the concentration of a pollutant in water that kills 50% of the organisms. Other types of toxicity tests measure how well species reproduce or grow.

FOR MORE INFORMATION:

Clear Creek Basin - The Effects of Mining on Water Quality and the Aquatic Ecosystem, prepared by CDOW, March 1991.

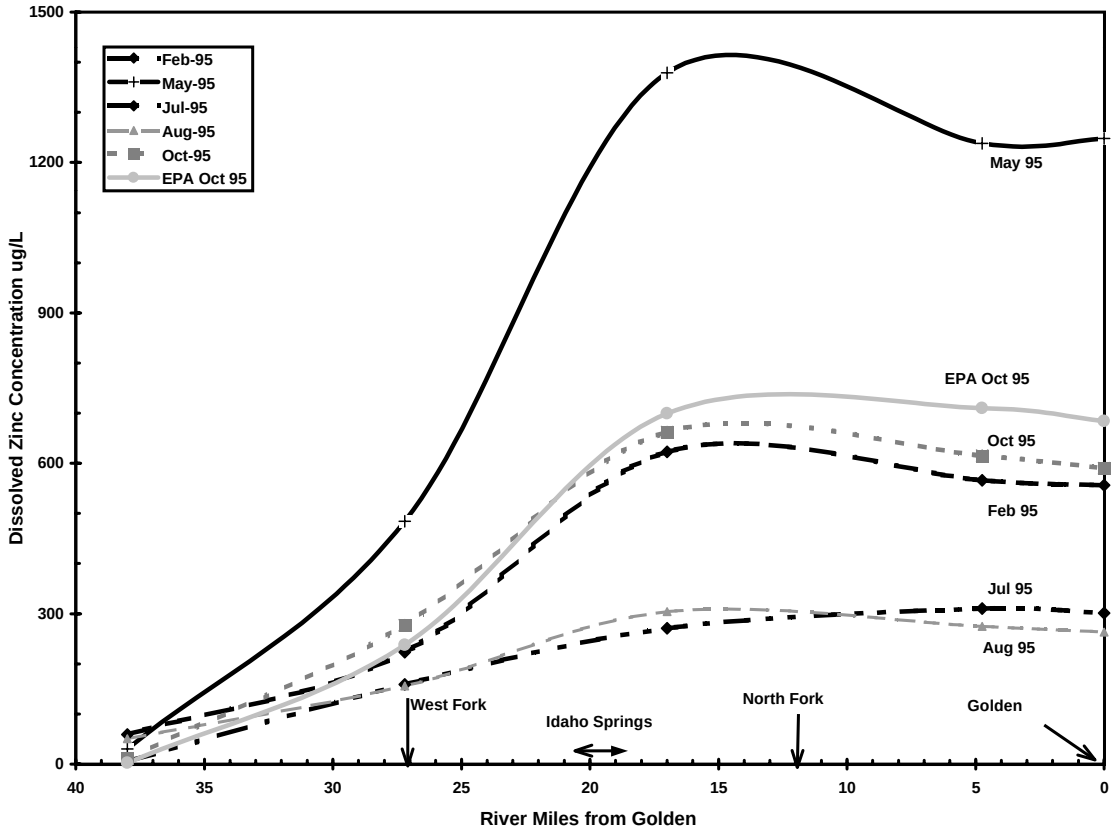
Clear Creek Phase II Remedial Investigation Report, prepared by Camp, Dresser, and McKee for the Colorado Department of Public Health and the Environment, September 21, 1990.

Chemical, Physical, & Biological Assessment of Clear Creek and Selected Tributaries in the Clear Creek Basin During Fall 1995, prepared by Water Science for the Environmental Protection Agency, September 1996.

TOXIC WATERS
Testing survival rates of aquatic species.

DISSOLVED ZINC CONCENTRATION OVER THE YEAR

Zinc concentrations and the concentrations of other metals fluctuate over any given year. The seasonal fluctuation affects toxicity. This graph shows the fluctuation in zinc for data collected in 1995. Zinc concentrations are higher during spring runoff when an extra measure of mine tailings and waste rock material is being washed into the river. May 1995, was an exceptionally high water month. Zinc levels are also high during the low flow months when there is not a lot of clean dilution water coming into Clear Creek. One of the October 1995 sample data sets was provided by the EPA and CDPHE Superfund program. The rest of the data sets are from the Upper Clear Creek Watershed Association, Standley Lake Cities, and EPA joint monitoring program.



IV. LIMITING FACTORS (CONT)

Habitat

Water quality is not the only factor limiting the health of Clear Creek. Aquatic habitat is also a concern. River gradient, channel width, meanders, the number and size of pools and riffles, bank cover provided by trees and other vegetation, and stream-bank stability are just a few measures of the quality of the aquatic habitat. In certain reaches of the Clear Creek watershed, the aquatic habitat has been impaired by, among other activities, historic placer mining and channelization for highway construction, most notably for Interstate-70. Placer mining is the removal of gold from the gravel and cobbles in and next to the stream bed.

The river bed itself is important to the aquatic community because many aquatic species live in the spaces between the river rocks and this is where trout lay their eggs. In Clear Creek, wintertime highway maintenance and erosion from mine tailings piles are a concern because sediment can fill the spaces between the rocks in the river bed. Increased sedimentation may reduce the number of aquatic species that can survive and also smother trout eggs that are located in the river bed.

Map 7 depicts the results of a habitat analysis conducted by EPA and CDPHE. The USDA Forest Service's Geographic and Wildlife Survey was used for the analysis. The North Fork of Clear Creek is the most severely impacted part of the watershed in terms of aquatic habitat, while portions of the upper main stem of Clear Creek and the West Fork of Clear Creek have very good habitats. The study indicated that, in general, the physical habitat of Clear Creek is sufficient to support more fish and other aquatic life than it does at this time.

HABITAT IMPROVEMENTS ARE HAPPENING: *There have been several recent efforts to improve the aquatic habitat in Clear Creek. In general, these improvements consist of adding pools and riffles to the river and planting vegetation along the stream banks. The Coors Brewing Company has restored a part of Clear Creek through the City of Golden. Near Dumont, at the McClelland mine property, a stream restoration and mine tailings cleanup effort was completed with the help of several participants including Coors Brewing Company, Clear Creek County, CDOT, CDPHE, and EPA. The City of Idaho Springs has restored and continues to restore Clear Creek through that city. Coors Brewing Company, CDOT, and EPA have been partners in the Idaho Springs effort, as well. The USDA Forest Service and CDOW have completed a stream habitat improvement project near the top of the watershed at Bakerville. CDOW also has teamed with the U.S. Fish and Wildlife Service to build habitat improvement structures in Bard Creek on the West Fork of Clear Creek.*

FOR MORE INFORMATION:

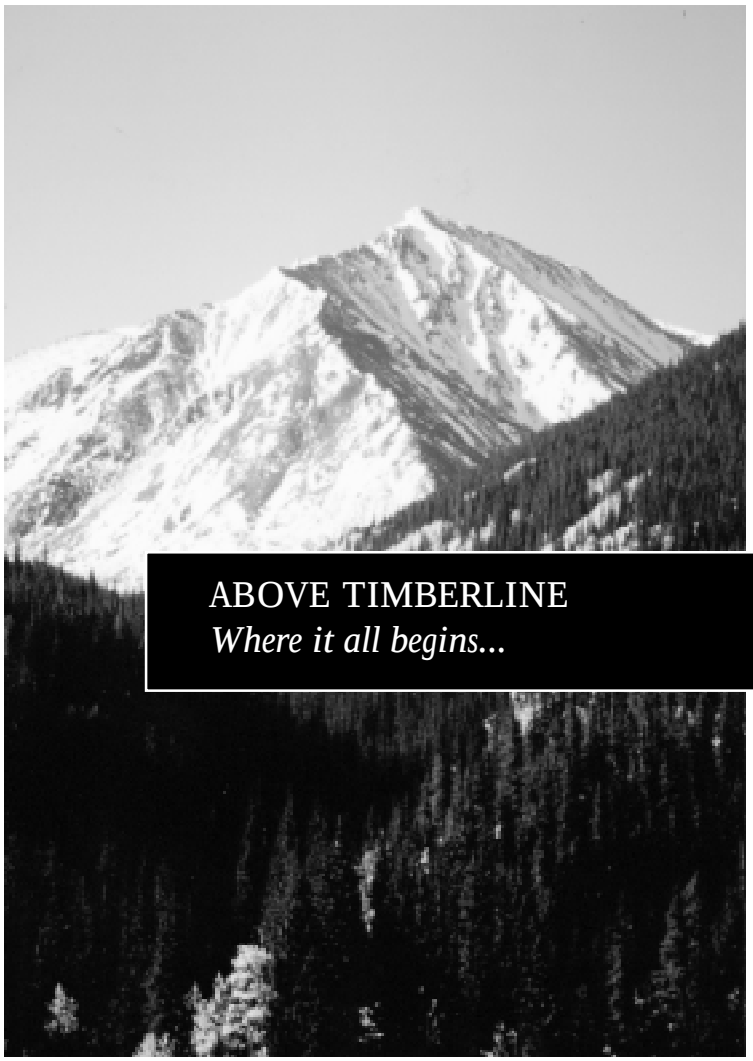
Clear Creek Phase II Remedial Investigation Report, prepared by Camp, Dresser, and McKee for the Colorado Department of Public Health and the Environment, September 21, 1990.

V. REGULATORY TOOLS & OTHER PROGRAMS

There are a number of regulatory tools and programs used to address contaminants, such as metals and nutrients, which are limiting the health of the Clear Creek watershed. These tools fall into two general categories: protection and remediation. Protection of water quality and stream habitat is provided by those laws or regulations which control current activities, while remediation is provided by programs which address historic pollution sources.

Protecting Surface Water

Certain laws, regulations, and programs are designed to protect surface water by limiting or minimizing pollution sources. One of the most important of these tools is the Clean Water Act. EPA has delegated the Clean Water Act program to many of the 50 states, Colorado being one of them. The Colorado Water Quality Control Commission, a governor-appointed board, oversees the implementation of the Clean Water Act in Colorado. The Commission is responsible for designating uses of the rivers and lakes in the state and setting the standards necessary to protect those uses. The Water Quality Control Division of CDPHE is responsible for administering the program.



ABOVE TIMBERLINE
Where it all begins...

WATER QUALITY STANDARDS: *The Colorado Water Quality Control Commission has established four classifications of uses for Colorado's surface water. These are aquatic life, domestic water supply, agriculture, and recreational use. For the aquatic life classification, the Commission has added a sub-designation, Class 1 or Class 2. Streams and lakes with a wide variety of aquatic species receive a Class 1 designation, while those rivers and lakes with an impaired aquatic system receive a Class 2 designation. The Commission also will identify whether the fishery is a cold water type characterized by trout or a warm water type characterized by species such as smallmouth bass.*

The Commission will divide a river into stream reaches and designate uses for each stream reach. The Commission then sets water quality standards to protect the designated uses. Sometimes the standards are simply a number, while other times the standards are based on a formula which has water quality hardness as a factor.

The Colorado Water Quality Control Commission has divided Clear Creek into 19 stream reaches. These are shown on Map 8, located in Chapter X of this report. The designated uses for each of those segments are listed in Table 9, also included in Chapter X. The Commission has established standards for each stream reach.

Owners and operators of wastewater treatment plants and industrial facilities are required to limit the amount of pollutants that are discharged to surface water from point sources through part of the Clean Water Act called the National Pollutant Discharge Elimination System (NPDES). Point sources of pollution, sometimes referred to as end-of-pipe discharges, are those which originate from a discrete source. Storm water discharges from certain industrial facilities and from municipal storm sewer systems serving populations of more than 100,000 people are also regulated as point sources under the NPDES program.

In Clear Creek, the major point source dischargers are the municipal wastewater treatment systems and two industrial facilities, Coors Brewing Company in Golden and the Henderson Mine, owned by Cyprus-Amax, near Empire. Map 9 shows their locations. All of these facilities have NPDES permits from CDPHE.

Inactive or abandoned draining mines contribute a significant amount of metals to the Clear Creek watershed every day. They pose a regulatory dilemma. The draining mines are point sources by regulatory definition and would normally fall under the NPDES program, but, in general, there are no viable "owners or operators" to whom the State could issue NPDES discharge permits. For this reason, cleanup of the water coming from these mines, if it is to occur at all, is left to the remediation programs discussed later in this chapter.

Non-point sources of pollution are those which originate from diffuse sources. Examples can include runoff from highways, fertilized fields, and lawns on a city block as long as the runoff is not directed into a discrete conveyance such as a pipe. Non-point sources of pollution are not subject to control under the NPDES program. Instead, regulation is left to local government.

Within the Clear Creek watershed, local governments have made a concerted effort over the last three years to reduce the amount of nutrients entering Clear Creek from non-point sources and from storm water. The Upper Clear Creek Watershed Association has prepared a BMP manual, and the guidelines contained in the manual have been adopted by all member organizations and several non-member organizations. Now, within the watershed, all disturbed areas of one acre or more should have BMPs in place. Other efforts include closing outhouses and upgrading septic systems. Illicit dumping in storm drains is being prohibited.

Protecting Wetlands and Stream Habitat

The Clean Water Act Section 404 protects wetlands, stream habitat, and riparian resources from the impacts of activities such as placer mining, construction in or near the stream bank, and the filling of wetlands for development. In general, Section 404 requires that a permit be obtained from the U.S. Army Corps of Engineers prior to the dredging or filling of wetlands, streams, or riparian areas. Section 404 does not address historic impacts to these areas.

Protecting Our Drinking Water

The Clear Creek watershed is a drinking water supply for nearly 350,000 people. It is important to protect and restore this significant resource. The Safe Drinking Water Act sets standards for municipal drinking water supplies, provides for inspections and enforcement, and most recently provides grants to cities to improve their water systems. Another part of the Safe Drinking Water Act is the Source Water Protection program designed to enable communities to protect their drinking water sources from contamination. Under the Source Water Protection program, communities identify the potential contamination sources of their drinking water supply and then determine the best way to manage the contamination. Included in this program is the Wellhead Protection program. The aim of the Wellhead Protection program is to protect groundwater wells, which are sources of drinking water.

Remediation Programs

While most environmental laws are intended to control or limit pollution, there are some regulatory mechanisms and programs designed to clean up historic problems. There are dozens of significant draining mine tunnels, mine tailings piles, and waste rock dumps in the watershed. By regulatory definition these are point sources but, frequently, there are no viable owners that can be required to clean up the pollution through the NPDES program. For this reason, these are the types of projects tailor-made for the Comprehensive Environmental Response, Compensation, and Liability Act, commonly called the Superfund Law.

ORPHAN MINE SITES: *The U.S. Geological Survey estimates there are 1,343 inactive or abandoned mines in the Clear Creek watershed. Only the Spring Creek watershed in Kansas, Missouri, and Oklahoma has more. (USGS Open-File Report #96-549)*

The Superfund law was passed by Congress in 1980 to address abandoned hazardous waste sites. The law requires EPA to identify sites across the nation needing to be cleaned up. The most contaminated of these sites are placed on what is called the National Priorities List. EPA will first seek to have those responsible for the polluted site pay for the cleanup. If there is no responsible party, or the responsible party is not financially viable, then EPA can pay for the cleanup using money from a trust fund generated largely by a tax on chemical and petroleum industries. In Colorado, CDPHE and EPA share responsibility for implementing Superfund cleanups.

The Clear Creek/Central City Superfund Site was listed on the National Priorities List in 1983. There are several completed or ongoing projects associated with the Clear Creek Superfund Site, and these are discussed in the next chapter, "Watershed Improvement Projects."

The Colorado Division of Minerals and Geology is also active in cleaning up mine tailings piles and waste rock dumps in the Clear Creek watershed. The Division relies on its Inactive Mine Reclamation program to complete much of this work. The Inactive Mine Reclamation program is funded by a tax on the coal mining industry. In addition to these monies, the Division frequently makes use of funding obtained from the Clean Water Act Section 319 program, commonly called the Non-Point Source program. There have been several "319" projects in the Clear Creek watershed and these are discussed in the next chapter, "Watershed Improvement Projects."

Volunteer Cleanups and Innovative Cleanup Tools

This section highlights three efforts intended to fill gaps in regulations and programs and expand the scope of cleanup activities in the watershed. The three are EPA's Regional Geographic Initiative, volunteer efforts, and the Orphan Sites program.

Over the last several years, EPA has provided funding through what is now called the Regional Geographic Initiative to organizations such as the Division of Minerals and Geology, local municipalities, and nonprofit groups. The money is used to accomplish watershed improvement projects where there are limited means of getting the work done. For example, this funding source has been used by Idaho Springs to restore Clear Creek stream habitat through the city.

The McClelland mine site, near Dumont, has been partially addressed through a volunteer effort. The project was undertaken by a public-private partnership of local businesses and governmental agencies; none of the parties involved had liability associated with the site. The entities completed part of a proposed project involving the capping and revegetation of an orphan tailings pile alongside Clear Creek. Another part of the project, the installation of a passive wetland treatment system to partially clean up the mine drainage from the tunnel, was temporarily suspended because of potential liability concerns related to the so-called Good Samaritan Issue.

THE GOOD SAMARITAN ISSUE: *Under the Clean Water Act, a volunteer—called a Good Samaritan—who does not have liability at a site and who attempts to partially improve the conditions at the site may be required to completely clean up the discharge to meet standards. Although EPA and CDPHE are supportive of these voluntary actions and are willing to address the Good Samaritan issue through administrative reforms, the Clean Water Act provides the opportunity for third-party lawsuits. Protection from third-party lawsuits can only be addressed through legislative action.*

ORPHAN SITES: *An orphan is a source of pollution which cannot be regulated under current laws or has no identifiable, responsible entity which can be located or has the means to address the pollution source. Examples of orphan sites include abandoned mine tailings piles, abandoned mine tunnel discharges, unstable road cuts, and impaired habitat.*

The Clear Creek watershed effort has an innovative project aimed at orphan sites. In 1994, the National Geographic Society and The Conservation Fund established the National Forum on Non-Point Source Pollution. The National Forum recommended supplementing regulatory approaches with educational programs, voluntary initiatives, and economic incentives. The National Forum initiated 25 demonstration projects to illustrate these various approaches.

One of the economic incentives projects was awarded by the National Forum to the Clear Creek watershed: "Adopting Orphan Sites for Credit." Under the orphan sites program an entity could adopt [and clean up] an orphan site to earn credits which could be later applied for a desired benefit. A feasibility study is underway and a demonstration project is being developed to test this concept.

FOR MORE INFORMATION:

Possible Approaches to Evaluating and Implementing Unlike Transactions, Orphan Sites Feasibility Study, Phase III, Task 3, prepared by Hydrosphere for The Conservation Fund, March 1997. (Copies available from EPA.)

Approaches to Evaluating and Implementing Transactions Involving Banking, Orphan Sites Feasibility Study, Phase III, Task 4, prepared by Hydrosphere for The Conservation Fund, September 1997. (Copies available from EPA.)

LOCAL CLEANUPS
Helping the efforts at orphan sites. Improving the end result.

VI. WATERSHED IMPROVEMENT PROJECTS

Cleaning Up Water from Abandoned Mine Tunnels

There are over 100 draining, inactive or abandoned, mine tunnels in the watershed. Altogether these tunnels are contributing an unknown but a likely significant amount of metals to Clear Creek. Various organizations have tested many individual mine tunnels, and it is generally known which ones are contributing the largest amount of metals to the river. These are the Burleigh Tunnel in Silver Plume, the Argo Tunnel in Idaho Springs, and the Gregory Incline in Black Hawk.

Probably the most effective way of dealing with water from a mine is to build a conventional water treatment plant. Plugging the draining tunnels or treating the mine water with constructed wetlands have met with only limited success in the Clear Creek basin and elsewhere. There are two water treatment plants for mine drainage in the watershed. Both will be operational this year and both will remove significant sources of metals to Clear Creek.

One plant is located at the Henderson and historic Urad mines. This plant was built by the owners of the mines, Cyprus-Amax, to achieve compliance with their NPDES permit. The other treatment plant was built at the Argo Tunnel by CDPHE and EPA using Superfund monies. CDPHE and EPA are considering whether or not to use Superfund monies to address the Burleigh Tunnel, the Gregory Incline, and other draining tunnels in the Clear Creek basin.

Cleaning up Abandoned Mine Sites

Mine tailings piles and waste rock dumps are another source of metals to Clear Creek. Nearly 20 of the most significant mine tailings piles and waste rock dumps in the Clear Creek watershed are being cleaned up by EPA and CDPHE under the Superfund program. (Their locations are shown on Map 9.) For example, the Minnesota Mine tailings pile on Lion Creek near Empire was cleaned up in 1996. This cleanup was jointly funded by the USDA Forest Service, EPA, and CDPHE.

Casino developers have cleaned up numerous Superfund designated mine tailings piles or waste rock dumps in Black Hawk and Central City. The developers are interested in doing the cleanups to provide land for limited stakes gambling opportunities in the two gaming towns. For example, in 1994, Bullwhackers cleaned up one of the most troublesome spots in Black Hawk, the Gregory Incline tailings, clearing way for the construction of a casino and parking lot.

Several mine tailings piles and waste rock dumps which are not part of the Superfund program have been addressed by the Colorado Division of Minerals and Geology using the Division's Inactive Mine Reclamation program. Through this program, and with additional funding from the Non-Point Source program, the Division has completed a cleanup of the Alice Mine at St. Mary's Glacier. Sometimes, the Division relies on bond money collected from defunct mining operations. Bond money was used to reclaim two abandoned cyanide-heap leaching facilities in Gilpin County, the Saratoga mine and the Solution Gold operation.

Map 10 shows the Clear Creek watershed improvement projects described above and others either completed or nearly underway. The Project 2000 List (Table 2) shows projects planned for the future.

Drinking Water Projects

A unique watershed improvement project is taking place to protect the drinking water supply of some individuals in Clear Creek. Through the Superfund program, CDPHE recently completed a 2-year effort where private well owners living in highly mineralized portions of the watershed could have their drinking water tested for possible presence of metals. Approximately 60 ground water well owners volunteered for the sampling program. Of those, five wells had levels of metals that were a concern. Those well owners are currently receiving bottled water, compliments of the Superfund program. CDPHE is evaluating long-term solutions for the five wells such as connecting each home to the nearest municipal drinking water system or providing in-home treatment units.

Other drinking water-related projects in the Clear Creek watershed concern spills from vehicles that travel along Interstate-70 and Highway 6. Each year, a number of spills occur that could contaminate water supplies. The U.S. Geological Survey, CDOT, and the Upper Clear Creek Watershed Association have completed studies to determine how long it takes for a spill to travel from a point in the upper watershed to Golden. This study will aid those who use Clear Creek water in determining how much time they have to shut down their water supply diversion structures. As an additional aid to the water suppliers, EPA has purchased an emergency call-down system. Once installed, the system will automatically alert users when a spill has occurred in the watershed.